NTD Germanium Thermistor Production For Cuoricino and CUORE

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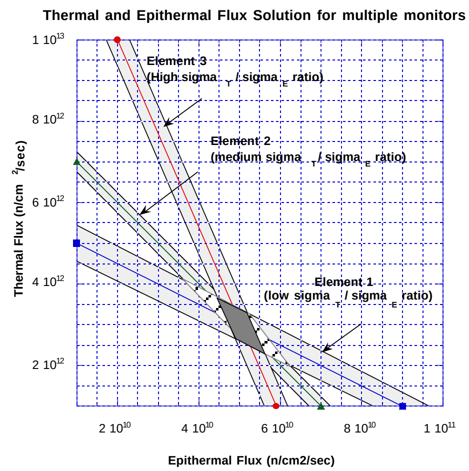
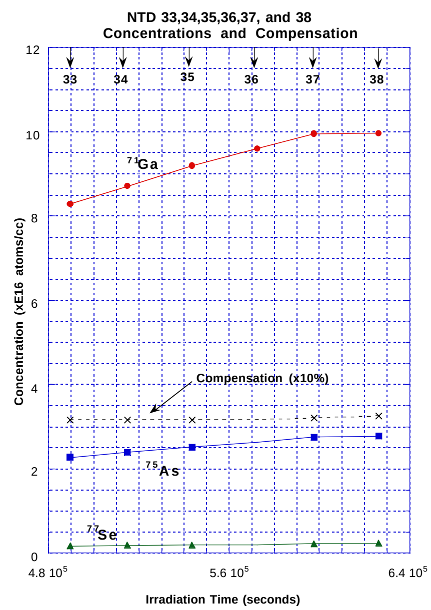
CUORE (**C**ryogenic **U**nderground **O**bservatory for **R**are **E**vents) is designed to be a large (750kg) array of 1000 TeO_2 crystals to search for rare events, particularly for the neutrinoless double beta decays of ^{128,130}Te. This experiment will succeed the MiBeta experiment, 20 crystals currently running, and CUORICINO (56 crystals) scheduled for installation later this year.

The thermistors used in these cryogenic detectors are produced by neutron transmutation doping (NTD) germanium. This involves subjecting Ge to about 3 x 10^{18} neutrons/cm^2 to produce doping levels of about 1 x 10^{17} Ga atoms per cm^3, 3 x 10^{16} As atoms per cm^3 and 2 x 10^{15} Se atoms per cm^3. The word “about” is not to imply that a large variance is acceptable. In fact, very precise doping is required since the doping must bring the Ge very near to the insulator/metal transition. The word “about” indicates the uncertainty in reactor parameters that leads to different doping concentrations observed under identical “nominal” reactor conditions. Because of this, doping has typically been done in a two-step process wherein the material has been measured after 90% expected dose, and the remaining dose calculated based on dose observed and nominal reactor parameters.

In an effort to better characterize the reactor parameters, we have developed a multiple-monitor method of flux measurement. For a given activation, a combination of thermal and epithermal fluxes provide the observed result. Where the bands for different monitors intersect is the solution for thermal and epithermal fluxes. A good combination of monitors involves ^{51}Cr, which is mainly a thermal neutron monitor; ^{59}Fe which is more influenced by epithermal neutrons, and ^{95}Zr which has a greater production cross section from epithermals than thermals. The following graph illustrates how three monitors give a solution for the thermal and epithermal neutrons. This allows us to predict the doping in the thermistor material.





This method will be used in future irradiations of Ge in an attempt to be able to do the doping more quickly. For example, as soon as the monitor foils are returned and counted, we will know if and how much additional irradiation is needed.

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